37. (New) A method for obtaining apomictic plants from sexual plants comprising:

(a) obtaining at least two sets of delineated sexual lines from a plant species or group of related plant species selected from the *Asteraceae* family and that are differentiated by their flowering responses to various photoperiods and by their start times and durations of female or seed developmental stages relative to development of nongametophytic ovule and ovary tissue; and

(b) hybridizing said sets of delineated sexual lines, recovering seed from the hybridization, sowing said seed, and selecting hybrid lines that express apomixis.

<u>REMARKS</u>

Claims 1-37 are present in the application. Claims 10, 13-15, 19-22, and 24-33 were withdrawn from consideration by the Examiner as non-elected claims. Therefore, only claims 1-9, 11-12, 16-18, 23, and 34-37 are currently under consideration. It is understood that claims 18 and 23 are under consideration only to the extent that they read on the elected claims, i.e., Group I.

Claims 1, 17, and 18 have been amended to clarify that the parent plants selected and hybridized to produce apomictic progeny are sexual plants. Support for this subject matter is found, for example, at page 41, lines 19-22.

Claims 1, 5, 6, 7, 17, and 18 are amended to add "or seed [developmental stages]". Early embryony is a seed developmental stage, and thus claim 5, which refers to early embryony, provides support for this addition.

Claims 2 and 3 were amended for consistency of terminology with other claims. Further, "day-neutral plants" was added to claim 2. Support for this addition is found, for example, in claim 18.

Claims 18 and 23 have been amended for adding punctuation and for limiting the scope thereof to elected subject matter. Applicant reserves the right to seek patent protection on the deleted subject matter in one or more continuing applications.

New claims 35-37 have been added to the application. Claim 35 is drawn to selection of parent plants from plant families known to naturally exhibit apomixis. Support for this limitation is found, for example, at page 1 line 16 through page 2 line 18. More particularly, J.G. Carman, 61 Biol. J. Linnean Soc. 51-94 (1997), which is incorporated into the application by reference, exhaustively lists families known to exhibit apomixis. Claim 36 is drawn to selection of parent plants from the grass family. Support for this limitation is found, for example, at page 1 line 16 through page 2 line 18. Claim 37 is drawn to selection of parent plants from the *Asteraceae* family. Support for this limitation is

found, for example, at page 1 line 16 through page 2 line 18, and page 46, lines 4-17.

No new matter is added to this application by virtue of these amendments.

For the information of the Examiner, claims substantially similar to those pending in the current application have been patented in corresponding Australian (Australian Patent No. 732743) and New Zealand (New Zealand Patent No. 337683) patent applications and have been allowed in a corresponding Eurasian patent application.

Applicant disagrees with the restriction requirement, but acknowledges that the Examiner has made the restriction requirement final.

I. Priority

The present application is a continuation of U.S. Serial No. 09/018,875, filed February 5, 1998, now abandoned, which claims the benefit of U.S. Provisional Application No. 60/037,211, filed February 5, 1997. The Examiner has alleged that the present application is not entitled to priority to U.S. Provisional Application No. 60/037,211 (hereinafter, "the '211 provisional application"), and the corresponding filing date of February 5, 1997. The basis for this allegation is the Examiner's allegation

that the '211 provisional application fails to provide enabling support for the presently claimed invention.

At page 3 of the '211 provisional application, it is stated that "across genome heterogeneity (intergenomic heterozygosity) for the time of reproductive development is responsible for apomixis." It is further stated at page 3 that

> apomixis is caused by asynchronous (overlapping) expression of whole cassettes of genes that are duplicated across genomes and that control entire female developmental sequences in ovules (MMC differentiation, meiosis, megagametophyte development, embryogenesis). Thus, only interactions between gene cassettes from specifically-divergent genomes will cause an appropriate degree of asynchrony and induce apomixis.

At page 4 of the '211 provisional application it is further stated that "the progeny or amphiploids from appropriately-selected parents (based on marker-assisted or cytologically-observable temporal differences in the timing of female development) will be apomictic."

It is clear from these statements alone that the basis for the presently claimed invention is hybridization of parents that exhibit substantial differences in the timing of female developmental stages and selecting apomictic progeny from such crosses.

Pages 16-53 of the '211 provisional application comprise a pre-publication manuscript that was later published as J.G. Carman,

Asynchronous expression of duplicate genes in angiosperms may cause apomixis, bispory, tetraspory, and polyembryony, 61 Biol. J. Linn. Soc. 51-94 (1997). This part of the '211 provisional application states at page 16 that "the partial to complete replacement of meiosis by embryo sac formation in apomictic and polysporic species results from asynchronously-expressed duplicate genes that control female development." This is followed by phylogenetic and genomic data that support the duplicate-genes asynchrony explanation for apomixis. Pages 45-53 is a comprehensive list of angiosperm orders, families, and genera that exhibit naturally occurring reproductive variants, including apomixis.

Pages 54-76 of the '211 provisional application comprise a pre-publication manuscript that was later published as M.D. Peel, J.G. Carman, Z.W. Liu & R.R.-C. Wang, Meiotic anomalies in hybrids between wheat and apomictic *Elymus rectisetus* (Nees in Lehm.) A. Löve & Connor, 37 Crop Sci. 717-723 (1997). This portion of the '211 provisional application comprises a description of cytological techniques useful in classifying stages of female floral development. Further, it is taught that diplospory may be caused by the expression of embryo sac signals from one genome precociously expressed with megasporogenesis signals from another genome. This teaches a person of ordinary skill in the art that

hybridization of parents with differing temporal schedules of female developmental stages would result in apomictic progeny.

Pages 77-105 of the '211 provisional application comprise a pre-publication manuscript that was later published as M.D. Peel, J.G. Carman & O. Leblanc, Megasporocyte callose in apomictic buffelgrass, Kentucky bluegrass, *Pennisetum squmulatum*, Fresen, *Tripsacum* L. and weeping lovegrass, 37 Crop Sci. 724-732 (1997). This portion of the '211 provisional application also describes cytological techniques useful in classifying female developmental stages.

Pages 106-107 of the '211 provisional application comprise claims that describe identifying parent plants that exhibit differences in timing of female reproductive development, hybridizing such parent plants to result in progeny plants that exhibit asynchronous overlapping expression of gene cassettes that are duplicated across genomes and that control timing of female reproductive development, and screening the progeny plants for asexual reproduction through seed, or, in other words, apomixis.

Methods of hybridization and screening for apomixis are well known in the art. Now that the inventor has disclosed that appropriate selection of parents for hybridization is critical for intentionally obtaining apomictic progeny from crosses of sexual parents, well known cytological methods can be used for identifying

the differences in timing of female developmental stages. Thus, a person of ordinary skill in the art would have been able to select parent plants, hybridize them, and screen for apomixis in the progeny based on what is disclosed in the '211 provisional application and what was then known in the art.

Therefore, the present application is entitled to a priority date based on the date of filing of the '211 provisional application.

Moreover, the J.G. Carman, 61 Biol. J. Linn. Soc. 51-94 (1997); M.D. Peel et al., 37 Crop Sci. 717-723 (1997); and M.D. Peel et al., 37 Crop Sci. 724-732 (1997), publications are not prior art with respect to the present application because the entire substance of these publications was disclosed in the '211 application.

Since pending claims have been rejected as allegedly lacking enablement under 35 U.S.C. § 112, first paragraph, the issue of enablement will be further addressed below.

II. <u>Drawing Objections</u>

The drawings in this application were objected to as informal. Formal drawings are enclosed. Therefore, withdrawal of the objection is respectfully requested.

III. Claim Objections

Claims 18 and 23 were objected to for alleged informalities in these claims. Namely, claim 18 was objected to for allegedly missing punctuation marks and for containing non-elected subject matter, and claim 23 was objected for containing non-elected subject matter.

Claims 18 and 23 have been amended herein for addressing these objections. Accordingly, withdrawal of these objections is respectfully requested.

IV. Rejections Under 35 U.S.C. § 112, Second Paragraph

Claims 1-9, 11-12, 16-18, 23, and 34 were rejected under 35 U.S.C. § 112, second paragraph, as allegedly being indefinite for failing to particularly point out and distinctly claim the subject matter that Applicant regards as the invention.

The second paragraph of 35 U.S.C. § 112 is directed to requirements for the claims:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

There are two separate requirements set forth in this paragraph: (1) the claims must set forth the subject matter that the applicants regard as their invention; and (2) the claims must particularly point out and distinctly define the metes and bounds

of the subject matter that will be protected by the patent grant.

MPEP § 2171.

With respect to the second of these requirements:

> The examiner's focus during examination of claims for compliance with the requirement for definiteness . . . is whether the claim meets the threshold requirements of clarity and precision, not whether more suitable language or modes of expression are available. . . . [The examiner] should allow claims which define the patentable subject matter with a <u>reasonable</u> degree of particularity and distinctness. . . . The essential inquiry pertaining to this requirement is whether the claims set out and circumscribe a particular subject matter with a reasonable degree of clarity and particularity. Definiteness of claim language must be analyzed, not in a vacuum, but in light of (1) the content of the particular application disclosure, (2) the teachings of the prior art, and (3) the claim interpretation that would be given by one possessing the ordinary level of skill in the pertinent art at the time the invention was made. If the scope of the invention sought to be patented cannot be determined from the language of the claims with a reasonable degree of certainty, a rejection of the claims under 35 U.S.C. 112, second paragraph is appropriate. *In re Wiggins*, 488 F.2d 538, 179 USPQ 421 (CCPA 1973).

MPEP § 2173.02 (emphasis in original); *In re Moore*, 169 U.S.P.Q. 236, 238 (C.C.P.A. 1971); *Hybritech Inc. v. Monoclonal Antibodies, Inc.*, 231 U.S.P.Q. 81, 94 (Fed. Cir. 1986); *Shatterproof Glass Corp. v. Libbey Owens Ford Co.*, 225 U.S.P.Q. 634, 641 (Fed. Cir. 1985). Further, breadth of a claim is not to be equated with indefiniteness. *In re Miller*, 441 F.2d 689, 169 U.S.P.Q. 597 (C.C.P.A. 1971). For example, if a claim is too broad because it is not supported by the original description or an enabling disclosure, then a rejection under 35 U.S.C. § 112, first

paragraph, is appropriate. Moreover, it has long been recognized that there is nothing inherently wrong with using functional language in drafting patent claims. The practical necessity of using functional language in certain circumstances has been recognized by the courts. *In re Swinehart*, 439 F.2d 210, 169 U.S.P.Q. 226, 228 (C.C.P.A. 1971) (citing *In re Halleck*, 421 F.2d 911, 164 U.S.P.Q. 647 (C.C.P.A. 1970). "A functional limitation must be evaluated and considered, just like any other limitation of the claim, for what it fairly conveys to a person of ordinary skill in the pertinent art in the context in which it is used." MPEP § 2173.05(g).

With that background in mind, the rejection of claims under 35 U.S.C. § 112, second paragraph, will now be discussed.

Claims 1, 17, and 18 were rejected for allegedly being indefinite for recitation of "related plant species." The Examiner alleged that this phrase fails to set forth the metes and bounds of the invention because all flowering plants are evolutionarily related. The claims are directed to those skilled in the art of plant breeding. Plant breeders recognize that hybrids can be made by crossing plants within the same species, the same genus, and the same family, but that it is probably unknown to make hybrids by crossing plants that are evolutionarily more distantly related. Nowhere in the instant application is the claim made that wider crosses can be made by following the presently claimed methods than

what is known in the art. Therefore, a person skilled in the art, after considering what is well known in the art and what is disclosed in the present application, would conclude that "related plant species" means species in the same family. Such a skilled person would further recognize that a greater likelihood of success is often obtained by hybridizing plants within the same genus. Hence, a person skilled in the art would understand that the claims define the patentable subject matter with a reasonable degree of particularity and distinctness. Withdrawal of this ground of rejection is, thus, respectfully requested.

Claim 1 was also rejected for allegedly being vague and indefinite for reciting "obtaining at least two sets of delineated lines from a plant species or group of related plant species that are differentiated by their flowering responses to various photoperiods and by their start times and durations of female developmental stages relative to development of nongametophytic ovule and ovary tissue." More particularly, the Examiner alleged that the claim does not delineate the recited lines, is unclear as to what criteria should be used to delineate the lines, and is indefinite "as to how many lines would be obtained to make the invention." A person skilled in the art of plant breeding, having an understanding of what is known in the art and what is disclosed in the present application, would understanding that the "delineated lines" are the selected parent plants that are to be

hybridized. The language of the claim itself makes clear that three criteria are used to select such parent plants: (1) different flowering responses to various photoperiods (e.g., induction and perpetuation of floral development), (2) start times of female or seed developmental stages relative to development of nongametophytic ovule and ovary tissue (e.g., onset of megasporogenesis, embryo sac formation and embryony), and (3) durations of female or seed developmental stages relative to development of nongametophytic ovule and ovary tissue (e.g., duration of megasporogenesis (includes the duration of the lag phase between meiosis and embryo sac formation) and embryo sac formation itself). Delineated lines (parent plants) that meet the noted criteria are identified or produced through standard plant breeding and selection procedures. Pairs of sexual parents meeting these criteria often contain among them the genetic variability sufficient to produce apomictic hybrids upon (1) crossing the sexual parents to produce F_1s, and (2) selecting F_1 hybrids that express apomixis. Following selection of apomictic F_1 hybrids, it would also be within the scope of the invention to then continue with either crossing the F_1s to a third line (or similarly-derived but genetically different F_1 hybrid), backcrossing, selfing, and/or doubling chromosomes if expression levels of the original hybrid are lower than desired. The latter procedures permit the

production of numerous uniquely segregated recombinants, which differ from each other in combinations of the critical divergent alleles important to the expression of apomixis (those that encode the critical photoperiodism characteristics and the ontogenetic timings and durations of critical seed development stages). The segregants are then tested for enhanced penetrance of apomixis according to well known procedures. It is respectfully submitted that this subject matter is described with a reasonable degree of particularity and distinctness, and a person skilled in the art would understand to a reasonable degree of certainty the metes and bounds of the invention. Concerning the number of lines needed to make the invention, as few as two ("at least two") developmentally divergent sexual parent lines may be used. As discussed above, subsequent selfing to produce an F_2, backcrossing to produce a BC_1, crossing with an additional line or hybrid to produce a double-cross, and the doubling of chromosomes may be desired to produce new lines with enhanced penetrance of apomixis (frequency of apomictically versus sexually derived seed from the apomict). When the parents of the F_1 are highly inbred, only a few F_1s (5 to 10) must be produced and screened for apomixis. If the parents of the F_1, F_2, BC_1, or double-cross are potentially heterozygous for the causal traits, then numerous recombinant progeny may be screened to obtain lines that approach maximal penetrance for apomixis. The

numbers are 500 to 1000 provided apomixis is observed among the first 20 progeny screened. No more than 20 randomly selected progeny should be screened if apomixis is not observed among the first 20 progeny. It is not considered undue experimentation, nor is it uncommon, for commercial plant breeders to select desired phenotypes from among tens of thousands of recombinant progeny in a single breeding program. Since these parameters would be understood by a person skilled in the art, withdrawal of this ground of rejection is respectfully requested.

The Examiner further rejected claim 1 for allegedly being vague, confusing, and indefinite for reciting "hybridizing . . . and selecting hybrid lines that contain genetic material of each said set of delineated lines such that asynchronous floral development, and therefore apomixis, is conferred." The Examiner alleged that the selection step is only for hybridity without a clearly defined step of identification or selection for the trait of apomixis. This is incorrect. The literal language of the claim states that selection is for hybrids that exhibit asynchronous floral development and apomixis. However, since it is redundant to state that hybrids are selected that contain genetic material from each parent, the claim has been amended to omit the redundant language and leave the selection for hybridity and apomixis. Withdrawal of this ground or rejection is respectfully requested.

Claims 1 and 17 were rejected for allegedly being confusing for suggesting that asynchronous floral development and apomixis are equivalent biological processes. The amendment to claim 1 has made this ground of rejection moot. Claim 17 has also been amended to remove redundant language, which also renders this ground of rejection moot. Therefore, withdrawal of the rejection is respectfully requested.

Claims 1-4 and 17-18 were rejected for allegedly being vague for recitation of "flowering response" and "flowering responses." At page 26, lines 1-5, of the specification divergence in temporal expression of female developmental schedules is discussed, including divergence in floral induction. At page 31, line 9, through page 33, line 12, there is a discussion of flowering responses to specific changes in photoperiod. Such flowering responses discussed include flower induction (e.g., page 31 lines 17-18, and 22) and maturation of flowers (e.g., page 31, 19). At page 32, lines 3-8, it is disclosed that Salisbury & Ross, Plant Physiology (1992), which was incorporated by reference into the specification, discloses 85 species of plants from among the approximately 300 species of plants studied as of the filing date that exhibit flowering responses to difference photoperiods. Thus, a person skilled in the art, considering what is known in the art and what is disclosed in the present application, would understand

that flowering responses include flower initiation (including days-to-flowering) and perpetuation of floral development. Withdrawal of this ground of rejection is respectfully requested.

Claims 5-6 and 18 were rejected for allegedly being vague and confusing in recitation of "early embryony." The Examiner has correctly stated that "early embryony" is not a part of a natural female developmental stage. It is, however, a part of a natural seed developmental stage. These claims are amended herein to clarify the stages included in "female developmental stage" by now reciting "female or seed developmental stage." Withdrawal of this ground of rejection is respectfully requested.

Claim 7 was rejected for allegedly being vague and confusing in the recitation of "is obtained by plant breeding." Claim 7 has been amended as suggested by the Examiner. Withdrawal of this ground of rejection is respectfully requested.

Claim 9 was rejected for allegedly being vague and confusing for recitation of "the genetic material comprises genomes from each set of delineated lines that confer appropriate degrees of asynchrony as measured by the expression of apomixis." Claim 9 has been amended and, as amended, does not contain the term "appropriate degrees of synchrony." Therefore, the ground of rejection is moot, and withdrawal of the rejection is respectfully requested.

Claims 17-18 were rejected for allegedly being vague, confusing, and indefinite and for allegedly omitting essential steps. Claims 17 and 18 are parallel in construction. Step (a) of each claim relates to identifying divergence in flowering responses to various photoperiods within a plant species or group of related plant species. Step (b) of each claim relates to obtaining two sets of lines that are differentiated by their flowering responses to various photoperiods, as identified in step (a). Step (c) of each claim relates to identifying within and between the sets of lines obtained in step (b) divergence in start times and durations of female or seed developmental stages relative to development of nongametophytic ovule and ovary tissues. Step (d) of each claim relates to obtaining delineated sexual lines that are differentiated by both their flowering responses to various photoperiods and their start times and durations for female or seed developmental stages relative to development of nongametophytic ovule and ovary tissues, as identified in step (c). Step (e) of each claim relates to producing hybrids by hybridizing the two sets of delineated sexual lines, obtained in step (d), and selecting for apomixis. Page 39, line 17, through page 41, line 11, discloses selecting and breeding sexual germplasm for producing apomicts. Page 41, line 12, through page 42, line 10, discloses hybridization processes. Page 44, lines 3-21, discloses procedures for verifying

expression of apomixis in hybrids. Based on what is known in the art and what is disclosed in the present specification, a person skilled in the art would understand what steps are to be undertaken to produce apomictic plants from sexual parents, as claimed. The Examiner's explanation of the basis for alleging that essential steps have been omitted from the claims is unclear and not understood by Applicant. Applicant has carefully considered the allegation, however, and finds no basis for it. Therefore, Applicant respectfully requests that the Examiner either explain clearly what is meant by the allegation that essential steps were omitted so that Applicant can appropriately respond, or withdraw the rejection on that basis. Applicant respectfully submits that a person skilled in the art would be reasonably apprised of the metes and bounds of the invention, thus the rejection should be withdrawn.

In view of the statement of the applicable law, explanations, and amendments presented herein, it is respectfully submitted that claims 1-9, 11-12, 16-18, 23, and 34 are in compliance with the requirements of 35 U.S.C. § 112, second paragraph, and withdrawal of the rejections on that ground is respectfully requested.

V. <u>Rejections Under 35 U.S.C. § 112, First Paragraph</u>

Claims 1-9, 11-12, 16-18, 23, and 34 were rejected under 35 U.S.C. § 112, first paragraph, as allegedly containing subject matter that was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention.

"The test of enablement is whether one reasonably skilled in the art could make or use the invention from the disclosures in the patent coupled with information known in the art without undue experimentation." *United States v. Telectronics, Inc.*, 857 F.2d 778, 785, 8 USPQ2d 1217, 1223 (Fed. Cir. 1988). See also, *In re Wands*, 858 F.2d 731, 737, 8 USPQ2d 1400, 1404 (Fed. Cir. 1988). However, a patent need not teach, and preferably omits, what is well known in the art. *Hybritech Inc. v. Monoclonal Antibodies, Inc.*, 231 U.S.P.Q. 81, 94 (Fed. Cir. 1986). Determining enablement is a question of law based on underlying factual findings. *In re Vaeck*, 20 U.S.P.Q.2d 1438, 1444 (Fed. Cir. 1991); *Atlas Powder Co. v. E.I. du Pont de Menours & Co.*, 750 F.2d 1569, 1576, 224 USPQ 409, 413 (Fed. Cir. 1984).

The fact that experimentation may be complex does not necessarily make it undue if such experimentation is typical in the art. *In re Certain Limited-Charge Cell Culture Microcarriers*, 221

USPQ 1165, 1174 (Int'l Trade Comm'n 1983), *aff'd sub nom.*, *Massachusetts Institute of Technology v. A.B. Fortia*, 774 F.2d 1104, 227 USPQ 428 (Fed. Cir. 1985); *In re Wands*, 858 F.2d at 737, 8 USPQ2d at 1404. The test of enablement is not whether any experimentation is necessary, but whether, if experimentation is necessary, it is undue. *In re Angstadt*, 537 F.2d 498, 504, 190 USPQ 214, 219 (CCPA 1976).

There are many factors to be considered when making a determination whether or not a disclosure satisfies the enablement requirement and whether or not any necessary experimentation is undue, among which are: (A) the breadth of the claims; (B) the nature of the invention; (C) the state of the prior art; (D) the level of one of ordinary skill in the art; (E) the level of predictability in the art; (F) the amount of direction provided by the inventor; (G) the existence or absence of working examples; and (H) the quantity of experimentation needed to make or use the invention based on the content of the disclosure. *In re Wands*, 858 F.2d 731, 737, 8 USPQ2d 1400, 1404 (Fed. Cir. 1988) (reversing the PTO's determination that claims directed to methods for detection of hepatitis B surface antigens did not satisfy the enablement requirement).

It is improper to conclude that a disclosure is not enabling based on an analysis of only one of the above factors while

ignoring one or more of the others. MPEP § 2164.01(a). The analysis must consider all of the evidence related to each of these factors, and any conclusion of nonenablement must be based on the evidence as a whole. 858 F.2d at 737, 740, 8 USPQ2d at 1404, 1407.

A. Breadth of the Claims

This invention relates to the intentional production of apomictic plants from sexual parents. While apomixis is known to occur naturally and has been obtained accidentally, prior to the invention of the presently claimed invention, apomixis has not been intentionally obtainable from sexual parents. Apomictic plants can now be intentionally produced by man, for the first time in history, from sexual plants by manipulating variation in photoperiodism, variation in onset and duration of specific seed development stages, and ploidy through conventional plant hybridization, chromosome doubling, and selection procedures. Therefore, this is a pioneering technology, and, as such, the technology is broadly claimed.

It has been consistently held that merely pointing out breadth in claim terminology is not sufficient to sustain an allegation of lack of enablement and that a party asserting lack of compliance with 35 U.S.C. § 112, first paragraph, has the burden of presenting cogent technical reasoning or objective evidence to support its

position regarding enablement. *Horton v. Stevens*, 7 USPQ 1245 (Bd. App. & Int. 1988).

Moreover, claims of various scopes are present in the application. Applicant is seeking broad patent protection on the presently claimed invention. However, claims of narrow and intermediate scope are also present in the application.

B. Nature of the Invention

This application relates to making hybrid plants. The elected claims relate to making hybrid plants by plant breeding. Plant breeding is a well known technology, and techniques used in the art of plant breeding, such as bagging or emasculation of female parents, pollination, identification and selection of apomictic hybrids, and the like, are routine and have been used for many years.

It should be recognized that the essential difference between the presently claimed invention and what was previously known in the art is the appropriate selection of parent plants to be used in the hybridization. If parent plants are correctly selected, then the processes of hybridizing the plants and selecting apomictic progeny are identical to processes already well known in the art.

The present invention resulted from the inventor (1) compiling information relevant to natural apomictic plants from the fields of

taxonomy, evolutionary biology, phylogenetics, cytogenetics, historical geology, embryology, developmental biology, ecophysiology, and genetics; (2) synthesizing the compiled information into a new theory of how apomictic plants evolve in nature, and (3) deriving processes, based on his novel and inventive discoveries and insights, as to how apomictic plants could be produced from sexual plants. Apomictic plants had not been intentionally produced from sexual plants by man prior to this invention. The processes of this invention include producing apomictic hybrids by crossing developmentally divergent sexual plants that produce their seed through normal but divergent sexual (not apomictic) development pathways. The inventor synthesized information from many interrelated disciplines to make this invention - a synthesis that was not obvious to others working in the field of apomixis. The elements of invention listed above are disclosed in the present application and well as in the U.S. provisional application to which priority is claimed. That is, after reading the provisional application or the present nonprovisional application, the invention becomes obvious to one skilled in the art as to processes and starting materials required to practice the invention of making apomictic plants from sexual plants.

C. State of the Prior Art

Conventional wisdom prior to the filing of the instant specification held that apomixis is caused by an apomixis gene (or two) that is simply inherited. This conventional paradigm is clearly challenged in the present application.

The state of the prior art is to attempt to transfer the supposed one or two apomixis genes into sexual plant lines by breeding with facultative apomictic plants. The present application repudiates the apomixis gene theory and is based on asynchrony of many duplicate genes required for female or seed development. Plant breeding is well known in the art. Any skilled plant breeder would be able to produce apomictic plants if provided with appropriately selected parent plants.

D. Level of One of Ordinary Skill in the Art

The level of skill of a person of ordinary skill in the art is relatively high. A person of ordinary skill in the art as of the filing date of the invention would know how to select plants for a plant breeding experiment. Such person would know that a realistic likelihood of obtaining viable progeny is possible when crossing plants within the same species, within the same genus, or within the same family. Such person would know that interfamily crosses are unlikely to yield viable progeny.

A person of ordinary skill in the art would know how to recognize different flowering responses to different photoperiods. For example, Salisbury & Ross, Plant Physiology (1992), describe such differences in flowering responses for 85 of the some 300 species for which such data had been published at the time of filing. As disclosed at pages 31-33 of the application, such responses include induction of flowering and maturation of buds into flowers. Further, Examples 3 and 4 at pages 51-55 disclose how methods for quantifying effects of different photoperiods on flowering.

A person of ordinary skill in the art would also know how to recognize differences between plants concerning their start times and durations of female or seed developmental stages relative to development of nongametophytic ovule and ovary tissue. For example, Example 5 at pages 55-57 discloses methods for quantifying divergence in female developmental schedules.

A person of ordinary skill in the art would know how to hybridize selected sexual plant lines by plant breeding. Such person would know how to recover seed from the hybridization, sow such seed, raise plants from such seed, and select hybrid lines from among the progeny. Such person would know how to recognize apomixis in plants.

E. Level of Predictability of the Art

The amount of guidance or direction needed to enable the invention is inversely related to the amount of knowledge in the state of the art, as well as the predictability of the art. *In re Fisher*, 427 F.2d 833, 839, 166 USPQ 18, 24 (CCPA 1970). In other words, the more that is known in the prior art about the nature of the invention, how to make, and how to use the invention, and the more predictable the art is, the less information needs to be explicitly stated in the specification. In contrast, if little is known in the prior art about the nature of the invention and the art is unpredictable, the specification would need more detail as to how to make and use the invention to be enabling. MPEP § 2164.03. Further,

> [t]he "predictability or lack thereof" in the art refers to the ability of one skilled in the art to extrapolate the disclosed or known results to the claimed invention. If one skilled in the art can readily anticipate the effect of a change within the subject matter to which the claimed invention pertains, then there is predictability in the art. On the other hand, if one skilled in the art cannot readily anticipate the effect of a change within the subject matter to which that claimed invention pertains, then there is lack of predictability in the art. . . . The scope of the required enablement varies inversely with the degree of predictability involved, but even in unpredictable arts, a disclosure of every operable species is not required.

MPEP § 2164.03.

The Examiner alleged that this art is so unpredictable that

an enabling disclosure has not been provided for the presently claimed invention. Applicant will now discuss the references cited by the Examiner.

The objective of the study reported by Hovin et al., 16 Crop Sci. 635-638 (1976) (hereinafter, "Hovin"), was to determine if the quality of seed produced by 41 different lines (introductions, cultivars, and experimental strains) of the naturally apomictic Kentucky bluegrass was affected by location of seed production (specific locations within seven states, which represented different latitudes, or natural photoperiod regimes, and different environmental conditions). Hovin concluded that (1) the quality of seed produced from naturally apomictic lines of Kentucky bluegrass is higher (fewer weak or aberrant seedlings) when seed is produced at higher latitudes (shorter periods of time in which anthesis may occur due to photoperiodism) and (2) the origin of the lines tested was not important to the former conclusion. This information is relevant to the processes of producing apomictic plants from sexual plants in terms of reciting standard methodologies known in the art for inducing flowering. In other words, conditions can be modified experimentally to induce flowering in introductions, cultivars, and experimental strains that would otherwise be difficult to work with. Likewise, the Purnhauser et al., 21 Cereal Res. Comm.

175-179 (1993) (hereinafter, "Purnhauser"), paper provides interesting methodology for facilitating the crossing of plants that do not flower at the same time (different sexual wheat lines). In other words, Purnhauser shows that techniques are well known in the art that permit crossing of non-synchronously flowering plants.

The objective of the Kenny et al., 136 Amer. Midland Naturalist 1-13 (1996) (hereinafter, "Kenny"), study was to determine if the naturally apomictic *Erigeron annuus* (a near obligate apomict) expresses greater ecological tolerances than the closely-related *E. philidelphicus* (an obligately sexual species). Plants of the two species were grown in a controlled environment with a single-photoperiod but with different degrees of shading. Under these conditions, the two species did not differ in their ecological tolerances. The Purnhauser paper discusses steps to "synchronize flowering dates" in a wheat breeding program (wheat is also obligately sexual), and teaches that synchronization of flowering dates is a well known issue in plant breeding and that techniques are available to achieve such synchronization.

In the plant breeding profession, synchronizing flowering dates to make desired crosses is referred to as "nicking" the plants, and it often involves growing plants in different

photoperiod regimes, planting seed at different times, and or vernalizing plants that have a vernalization requirement for flowering. While nicking procedures will on occasion be important for accomplishing certain crosses, such procedures are commonly understood to those skilled in the art. Thus, plenty of guidance is well known in the art for obtaining synchronization of flowering dates. Thus, no undue experimentation is required, because such techniques are routine and plant breeders know that synchronization of flowering dates is an issue that may need to be dealt with, and they know how to deal with it.

Bates, Proceedings of World-wide maize improvement in the 70's and the role of CIMMYT (1974) (hereinafter, "Bates") and Garcia et al., 74 Maize Genet. Coop. Newsletter 40-41 (2000) (hereinafter, "Garcia"), teach difficulties in and solutions for accomplishing interspecific and intergeneric hybridizations in plants. It is widely recognized that difficulties in achieving wide hybridization usually increase with the divergence of the cross, and specialized techniques, such as embryo rescue, the use of specific genotypes, and the pollination of large numbers of pistils, are often used (J. Torabinejad, J.G. Carman, C.F. Crane, 29 Genome 150-155 (1987); Z.-W. Liu, R.R.-C. Wang, J.G. Carman, 89 Theor. Appl. Genet. 599-605(1994)). However, wide hybridization is not a necessary component for practicing the

methods of the instant application. What is claimed is that the same methodology used to produce apomictic plants from sexual plants within species can be used among species regardless of the understood additional numbers of pollinations and other procedures that may be required to achieve interspecific hybridization.

An objective of the DeWet et al., 23 Caryologia 183-187 (1970) (hereinafter, "DeWet") study was to determine if the apomixis trait could be readily transferred from *Tripsacum* to corn (*Zea mays*) by hybridization. DeWet teaches the crossing of sexual *Zea mays* (2n = 2x) as female with apomictic *Tripsacum dactyloides* (2n = 4x) as male. DeWet teaches the recovery of sexual triploid progeny that tend to be genetically stable when backcrossed to maize. This occurred because of an unusual elimination of maize chromosomes during megasporogenesis in the intergeneric triploid hybrid, the unusual retention of a diploid complement of *Tripsacum* chromosomes during megasporogenesis, and the restoration of a haploid complement of maize chromosomes upon fertilization by maize sperm to restore the triploid number. In DeWet the occasional genetic instability noted in this system was caused by sexual meiosis, not apomeiotic processes. DeWet explored the transfer of apomixis genes from an apomictic wild plant to a related sexual crop through introgression

(hybridization and backcrossing).

A variety of methods have been developed for clearly differentiating sexually-derived progeny of a facultative apomict (a plant that produces seed both sexually and apomictically) from apomictically-derived progeny from the same facultative apomict. The most reliable methods involve dominant morphological or codominant molecular markers, and powerful molecular procedures, e.g. SSRs, RAPDs, etc., are now being used for this purpose (O. Leblanc & A. Mazzucato, Screening procedures to identify and quantify apomixis, in *The Flowering of Apomixis: From Mechanisms to Genetic Engineering*, Mexico, D.F.: CIMMYT, IRD, European Commission DG VI, FAIR (Y. Savidan, J.G. Carman, T. Dresselhaus eds 2001). On pages 11 through 14 of the Office Action, the Examiner cites several authors (Hovin; Garcia; deWet; Hanna et al., 27 Crop Sci. 1136-1139 (1987) (hereinafter, "Hanna"); Holm et al., 125 Hereditas 77-82 (1996) (hereinafter, "Holm")), from which he concludes that in the absence of reliable histological, chromosome counting, karyotyping, and progeny test marker techniques, the screening of apomictic plants for percentage apomictic progeny (versus sexual progeny) is unpredictable. Applicant has no argument with this, however, in the same breath it must be recognized that such techniques are well known in the art. The process of selecting apomictic progeny from a

hybridization of parent plants encompasses these techniques. .

Hovin discloses histological procedures to observe and describe the development of both sexual and aposporous embryo sacs in apomictic Kentucky bluegrass accessions. In aposporous species, it is normal for a sexual embryo sac and one or more aposporous embryo sacs to initiate formation at about the same time within the same ovule. Generally, in such ovules, sexual embryo sac formation aborts (sometimes the meiocyte aborts prior to the embryo sac stage), the aposporous embryo sac(s) then absorbs the remains of the degenerating sexual meiocyte or embryo sac, and the aposporous embryo sac matures and becomes functional. Hovin concluded that histological analyses for verifying aposporous embryo sac formation in Kentucky bluegrass are only reliable when pistils are examined at early stages, e.g. the megasporogenesis stage of seed development. This is a common condition of accurate embryological assessments of apomictic expression, and it is exactly how Applicant documents aposporous embryo sac formation in the *Sorghum* lines Applicant has developed that produce aposporous embryo sacs (Declaration of John G. Carman under 37 C.F.R. § 1.132). In older Kentucky bluegrass pistils, Hovin noted that it is impossible to determine if a maturing embryo sac is of sexual or apomictic origin. Again, this is a common and well documented limitation of histological

methods for determining if plants are reproducing sexually or apomictically. In practice, if a pistil is too old or too young, it is discarded and a younger or older pistil is analyzed. The current convention is to analyze pistils that are in the megasporogenesis to one nucleate embryo sac stage. At these stages, reliable estimates of percentage apomictic embryo sac formation (both diplosporous and aposporous) compared to percentage sexual embryo sac formation can usually be obtained. In rare cases, apospory is initiated after megasporogenesis, so it is important to modify the verification procedure by collecting early embryo sac stage pistils. In any event, procedures for obtaining accurate estimates are commonly understood by those currently working in the field (e.g., S.E. Asker & L. Jerling, Apomixis in plants (CRC Press, Boca Raton, Fla. 1992); Y. Savidan, J.G. Carman, T. Dresselhaus, *The Flowering of Apomixis: From Mechanisms to Genetic Engineering*, Mexico, D.F.: CIMMYT, IRD, European Commission DG VI, FAIR (2001)).

As noted by Hovin, Garcia, deWet, Hanna, and Holm, the determination of whether a plant is producing seed apomictically or sexually is best accomplished through a combination of embryological (histological) analyses and progeny tests, and reliable procedures for both are available (reviewed by O.

Leblanc & A. Mazzucato, Screening procedures to identify and quantify apomixis, in *The Flowering of Apomixis: From Mechanisms to Genetic Engineering*, Mexico, D.F.: CIMMYT, IRD, European Commission DG VI, FAIR (Y. Savidan, J.G. Carman, T. Dresselhaus eds 2001). The references cited in the Office Action discuss ways to determine if progeny of a plant are produced apomictically or sexually. Such determinations are secondary to practicing the methods of the instant specification. What is claimed is a method for producing apomictic plants from sexual plants, which afterwards may use variously established methodologies for documenting the production of apomictic embryo sacs in ovules and the frequency in which seeds of a given man-made apomictic plant are produced apomictically (through progeny tests involving morphological and molecular markers).

On pages 14-15 of the Office Action, Hanna; J.G. Carman, 61 Biol. J. Linn. Soc. 51-94 (1997) (hereinafter, "Carman-Linnean"); and Bashaw et al., Apomictic Grasses, in 2 Principles of Cultivar Development - Crop Species 40-82 (MacMillan 1987) (hereinafter, "Bashaw"), are cited as indicating that the number of genes and genetic modifiers important to the expression of apomixis is unknown but may include one to a few genes with major effects and several or more modifiers with minor effects. As an initial point, Carman-Linnean is not a proper reference against the

present application. U.S. Provisional Application No. 60/037,211, filed February 5, 1997, to which the present application claims priority contains the entire text of the Carman-Linnean article. Pages 16-53 of U.S. Provisional Application No. 60/037,211 is a manuscript of the Carman-Linnean article that was filed in the U.S. Patent and Trademark Office prior to the publication of the article. Furthermore, Carman-Linnean is quoted as suggesting that some traits required for the evolution of apomixis may be quantitative traits, which further complicates (make unpredictable) breeding efforts to assemble the specific but uncharacterized alleles at numerous uncharacterized loci to produce apomictic plants. With this information alone, the production of apomictic plants from sexual plants would clearly appear to be unpredictable and to require undue experimentation.

It is important to note that those who reject the idea of multiple genes being involved (who believe apomixis is simply inherited via an apomixis gene) point to the fact that any partial assembly of the essential alleles in a plant through plant breeding would tend to be deleterious to plant fertility, which would further complicate the production of apomictic plants from sexual plants. For example, failure of meiosis without unreduced embryo sac formation causes sterility, and unreduced

embryo sac formation without parthenogenesis causes fatally excessive polyploidy. Hence, it is argued that apomixis could not have evolved by "evolutionary steps" involving the gradual accumulation of unique mutations (or unique alleles) the sum of which encode apomixis because too many intermediate stages, between sexual fertility and apomixis fertility, are sterile. Hence, those arguing that apomixis is simply inherited argue that one to a very few mutation(s) that confer apomixis (the apomixis gene hypothesis) is the most likely explanation for the evolution of apomixis (see S.E. Asker & L. Jerling, *Apomixis in Plants* (CRC Press, Boca Raton, FL 1992); M. Mogie, *The Evolution of Asexual Reproduction in Plants* (Chapman and Hall, London 1992); Y. Savidan, J.G. Carman & T. Dresselhaus, *The Flowering of Apomixis: From Mechanisms to Genetic Engineering*, Mexico, D.F.: CIMMYT, IRD, European Commission DG VI, FAIR 2001).

The inventor discovered, and disclosed in both the provisional application and the present nonprovisional application, that the seemingly complex situation in which many genes are required for the expression of apomixis is not as evolutionarily unlikely as taught in the conventional literature (discussed above), and that the production of apomictic plants from sexual plants by man can be predictable. The inventor reached this conclusion based on his pioneering discoveries as

follow: (1) the important genes and modifiers required to express apomixis are not "apomixis genes" per se but are genes (with multiple alleles in natural populations) that encode normal floral induction processes and normal sexual seed development processes, (2) within angiospermous species, genera, or families, the normal floral and seed development processes involved in the evolution of apomixis are highly variable among ecotypes, in terms of ontogenetic timing (due to variously adaptive among-ecotype polyallelism), but tend to be invariable within ecotypes (due to natural selection within ecotypes), (3) the ecotypically unique ontogenetic types of expression of normal floral and seed development processes represent readily distinguishable ontogenetic phenotypes that are readily quantifiable by commercial pace processes, (4) apomixis evolves in nature somewhat instantaneously (generally one to three hybridization steps, instead of numerous steps in which alleles accumulate gradually and intermediates are sterile) through inter-ecotypic (secondary-contact) hybridizations among divergent ecotypes that express normal but specifically divergent floral and sexual seed development processes, and (5) the evolutionary steps responsible for apomixis arising in nature can be mimicked and accelerated by man in commercial-pace plant breeding programs designed to produce apomictic plants from sexual plants. By understanding

the phenotypes of the major genes and modifiers responsible for apomixis, it is possible to identify pairs of divergent sexual plants that produce apomictic plants when hybridized.

F. Amount of Direction Provided by the Inventor

The application contains a thorough explanation of how the present duplicate-gene asynchrony approach to making apomictic plants is consistent with the observations that have made in the apomixis field over many years and further explains why the theories and assumptions of the prior art are deficient. At pages 39-44 of the specification are detailed explanations of (a) selection or production of sexual germplasm appropriate for use in producing apomictic plants from sexual plants, (b) hybridization processes used in producing such apomictic plants, (c) amphiploidation processes useful under many circumstances for making apomictic plants, and (d) procedures for verifying expression of apomixis. Examples 1 and 2 at pages 45-51 describe selecting and collecting germplasm for both dicots and monocots. Examples 3 and 4 at pages 51-55 describe quantifying effects of different photoperiods on flowering for both dicots and monocots. Example 5 at pages 55-57 describes quantifying divergence in female developmental schedules. Example 6 at pages 58-59 describes methods for obtaining greater divergence in female

developmental schedules. Examples 7 and 8 at pages 60-62 describe making apomictic plants from sexual lines divergent in floral development.

It should be recognized that the processes of hybridization of selected parent plants and selection of apomictic progeny are well known in the art and have been routine in plant breeding for many years. The critical difference between the presently claimed invention and the prior art is in the identification and selection of parental germplasm. Many of the techniques for identifying such germplasm are already known in the art but, until the present application, had not been used for the presently claimed purposes. With the guidance provided in the present application, it would be a routine matter for a person skilled in the art to select appropriate germplasm and then carry out the hybridization and selection processes for obtaining apomictic plants as claimed.

G. <u>Working Examples</u>

Compliance with the enablement requirement of 35 U.S.C. § 112, first paragraph, does not turn on whether a working example is disclosed. MPEP § 2164.02. The presence or absence of working examples, however, is a factor to be considered.

Example 3 is a working example of quantifying effects of

different photoperiods on flowering, with *Antennaria* species used as an example. Example 5 is a working example of quantifying divergence in female developmental schedules, with *Tripsacum* used as an example.

Further, additional working examples were provided in the Declaration of John G. Carman Under 37 C.F.R. § 1.132 filed on February 9, 2001. In this Declaration, Dr. Carman disclosed that apomixis was obtained in both dicotyledonous (*Antennaria*) and monocotyledonous (*Sorghum* and *Tripsacum*) plants using the methods described and claimed in the present application. In three attempts, Dr. Carman successfully obtained apomictic hybrids all three times.

Although the Examiner acknowledged considering this Declaration, the fact that no further comment was made on the facts supplied in the Declaration begs the question whether the Examiner gave appropriate weight to such facts. The Declaration shows that when the steps of the presently claimed invention are followed as described in the specification, then apomixis is obtained.

H. Quantity of Experimentation

Some experimentation will likely be necessary with each new species or genus of plant used in making apomictic hybrids.

However, based on the guidance provided in the specification, such experimentation would be merely routine.

Based on all of these factors, the great preponderance of the evidence weighs in favor of an enabling disclosure having been provided. For these reasons, it is respectfully submitted that the requirements of an enabling disclosure under 35 U.S.C. § 112, first paragraph, have been met. Thus, withdrawal of the rejection on this ground is respectfully requested.

VI. Rejection under 35 U.S.C. § 102(b)

Before discussing rejections based upon 35 U.S.C. § 102, it is proper to state that to sustain a rejection under § 102 the Patent and Trademark Office must abide by the following statement of the law.

> Under 35 U.S.C. § 102, anticipation requires that each and every element of the claimed invention be disclosed in a prior art reference. *W.L. Gore & Associates, Inc. v. Garlock, Inc.*, 721 F.2d 1540, 1554, 220 USPQ 303, 313 (Fed. Cir. 1983), *cert. denied*, 469 U.S. 851 (1984). In addition, the prior art reference must be enabling, thus placing the allegedly disclosed matter in the possession of the public. *In re Brown*, 329 F.2d 1006, 1011, 141 USPQ 245, 249 (CCPA 1964).

Akzo N.V. v. U.S. Int'l Trade Comm'n, 1 U.S.P.Q.2d 1241, 1245 (Fed. Cir. 1986).

The Examiner has rejected claims 1-9, 11-12, 16, 23, and 34

for allegedly being anticipated by S. Saran et al., 11 J. Cytol. Genet. 22-28 (1976) (hereinafter, "Saran").

Saran describes the effects of different photoperiods on facultativeness of a facultatively apomictic tetraploid *Dichanthium intermedium* hybrid whose parents were also members of the facultatively-apomictic species *D. intermedium* (page 22, first sentence, Materials and Methods). The last sentence of the introduction (page 22) implicitly states what the paper deals with, i.e. "the effect of photoperiod on the mode of reproduction in the facultatively apomictic compilospecies, *Dichanthium intermedium*." More succinctly, Saran describes apomictic hybrids produced from apomictic parents. Neither this paper nor subsequent review articles and books on apomixis that review this paper (e.g., S.E. Asker & L. Jerling, Apomixis in Plants 90 (CRC Press 1992); M. Mogie, *The Evolution of Asexual Reproduction in Plants* 150 (Chapman and Hall, London 1992), disclose or suggest that Saran produced (or claimed to have produced) an apomictic *Dichanthium* by hybridizing two sexual *Dichanthium* genotypes (absence of facultative expression of apomixis).

Saran did not disclose or suggest that apomictic plants could be produced from sexual plants by hybridizing specifically "delineated lines from a plant species or group of related plant species that are differentiated by their flowering responses to

various photoperiods and by their start times and durations of female developmental stages relative to development of nongametophytic ovule and ovary tissue." Saran did not disclose or suggest a causal relationship between the hybridization of sexual plants with different photoperiodism characteristics (or different timings and durations of megasporogenesis and embryo sac formation) and the genetic capacity of a plant to undergo apomixis. There is no evidence that Saran or others before or after the Saran paper, anticipated the degree of variation in start times and durations of megasporogenesis and embryo sac formation, which the present inventor discovered and which forms the basis of the instant specification. Saran simply fails to disclose or suggest a process for producing apomictic plants from sexual plants. Hence, none of the claims of the instant specification are anticipated by Saran.

For the reason that Saran fails to disclose each and every element of the presently claimed invention, withdrawal of the rejection of claims 1-9, 11-12, 16, 23, and 34 under 35 U.S.C. § 102(b) is respectfully requested.

VII. <u>Rejection Under 35 U.S.C. § 103</u>

Before responding directly to the issues raised by the Examiner under Section 103, the legal foundation for sustaining

such a rejection will be reviewed. Briefly, the burden is first on the Patent Office to establish a *prima facie* case of obviousness. *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596, 1598 (Fed. Cir. 1988). If no *prima facie* case of obviousness is established, then a rejection under Section 103 cannot properly be sustained. *In re Oetiker*, 24 U.S.P.Q.2d 1443 (Fed. Cir. 1992). If the Patent Office establishes a *prima facie* case of obviousness, then the burden of production shifts to the applicant to provide appropriate rebuttal, although the burden of persuasion always remains with the Patent Office. *Id.* Such rebuttal may include arguments, amendments, and/or presentation of objective indicia of nonobviousness. However, such objective indicia are always relevant to a determination of nonobviousness whether or not a *prima facie* case of obviousness has been established. *Stratoflex Inc. v. Aeroquip Corp.*, 218 U.S.P.Q. 871, 879 (Fed. Cir. 1987). To establish a *prima facie* case of obviousness, the Examiner must show all of the limitations of the claimed invention in the prior art. *In re Ehrreich*, 200 U.S.P.Q. 504, 509-11 (C.C.P.A. 1979). The subject matter of the invention must be considered as a whole and through the eyes of a hypothetical person of ordinary skill, not expert skill, in the relevant art at the time the invention was made. *Connell v. Sears, Roebuck & Co.*, 220 U.S.P.Q. 193, 199 (Fed. Cir. 1983). References must also be considered as a whole, including subject

matter that teaches away from the invention as well as subject matter that suggests the invention, and not for their isolated teachings. *Ashland Oil, Inc. v. Delta Resins & Refractories, Inc.*, 227 U.S.P.Q. 657, 669 (Fed. Cir. 1985). References may be combined if there is a suggestion, motivation, or incentive in the prior art to make such a combination. *In re Dillon*, 16 U.S.P.Q.2d 1897, 1901 (Fed. Cir. 1990) (en banc); *In re Jones*, 21 U.S.P.Q.2d 1941, 1943-44 (Fed. Cir. 1992). It is not permissible to use hindsight to pick and choose among isolated teachings in the art after first having read Applicant's application to learn the pattern of the invention. *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596, 1600 (Fed. Cir. 1988).

Pursuant to established legal authority, patentability under 35 U.S.C. § 103 requires a four-step analysis, which involves determining (1) the scope and content of the prior art, (2) the differences between the prior art and the claimed inventions, (3) the level of skill in the art, and (4) the objective evidence of nonobviousness that may have been presented. *W.L. Gore & Assocs., Inc. v. Garlock, Inc.*, 220 U.S.P.Q. 303, 311, 314 (Fed. Cir. 1983). After all of these factors have been considered, the ultimate legal conclusion on the issue of obviousness must be reached. With the above background in mind the rejections under 35 U.S.C. § 103 will be discussed.

Claims 1-9, 11-12, 16-18, 23, and 34 were rejected under 35

U.S.C. § 103(a) as allegedly being obvious over Saran in view of Bashaw et al., Apomictic Grasses, in 2 Principles of Cultivar Development 40-82 (Fehr ed. 1987) (hereinafter, "Bashaw").

The teachings of Saran were reviewed above. Briefly, Saran discloses production of apomictic plants from apomictic parents. Saran further discloses the effects of different photoperiods on facultativeness of a facultatively apomictic tetraploid *Dichanthium intermedium* hybrid.

Bashaw discloses that results of genetic investigations of hybrids between sexual and apomictic plants indicate simple inheritance of apomixis. Bashaw at 45. More particularly, Bashaw states that data suggest that no more than two genes control apomixis in grasses. *Id.* Bashaw cites *Bothriochloa-Dichanthium* complex (no more than one gene per genome), bahiagrass (controlled by a few recessive genes), guineagrass (sexuality controlled by at least 2 loci and conditioned by 2 dominant alleles), and buffelgrass (controlled by two epistatic genes) and birdwoodgrass as examples of such simple inheritance of apomixis. Bashaw at 45-46. Bashaw fails to disclose or suggest that apomixis can be produced by hybridizing two sexual parents that differ with respect to responses to photoperiods and with respect to timing of female flowering

Claim 1 is an independent claim drawn to a method for

obtaining apomictic plants from sexual plants comprising obtaining at least two sets of delineated <u>sexual</u> lines that are differentiated by their flowering responses to various photoperiods and by their start times and durations of female developmental stages relative to development of nongametophytic ovule and ovary tissue; and hybridizing such sets of delineated <u>sexual</u> lines and selecting hybrid lines that exhibit apomixis. Neither Saran nor Bashaw, either alone or in combination, discloses or suggests (1) obtaining such sexual lines that differ in their responses to various photoperiods and by their start times and durations of female or seed developmental stages, (2) hybridizing such sexual lines, or (3) selecting hybrid lines produced from the hybridization such that exhibit apomixis. Therefore, the Examiner has not shown all the limitations of the claimed invention in the prior art. Hence, the Examiner has failed to establish a *prima facie* case of obviousness concerning claim 1.

Claims 2-9, 11, 12, and 16 are dependent on claim 1 and, thus, incorporate by reference the limitations of claim 1. Since the Examiner has not shown all the limitations of claim 1 in the prior art, the same is also true of the limitations of claims 2-9, 11, 12, and 16.

Further, claims 2 and 3 are drawn to the method of claim 1 wherein the differentiation in flowering response occurs,

respectively, within or across short-day plants, long-day plants, dual-day-length plants, intermediate-day-length plants, ambiphotoperiodic plants, or day-neutral plants. Neither Saran nor Bashaw discloses or suggests these claimed limitations. Thus, the Examiner has not shown all the limitations of the claimed invention in the prior art, and, therefore, a *prima facie* case of obviousness has not been established concerning claims 2 and 3.

Claim 4 is drawn to the method of claim 1 wherein differentiation of flowering responses to various photoperiods is obtained by plant breeding. Neither Saran nor Bashaw discloses this claimed limitation. Thus, the Examiner has not shown all the limitation of the claimed invention in the prior art, and, therefore, a *prima facie* case of obviousness has not been established concerning claim 4.

Claims 5 and 6 are drawn to the method of claim 1 wherein differentiation in start times and durations of female developmental stages occurs, respectively, within and across archespore formation, megasporogenesis, megagametogenesis, or early embryony. Neither Saran nor Bashaw discloses or suggests this limitation. Thus, the Examiner has not shown the existence of this claimed limitation in the prior art, and, therefore, a *prima facie* case of obviousness has not been established concerning claims 5 and 6.

Claim 7 is drawn to the method of claim 1 wherein differentiation in start times and durations of female developmental stages is obtained by plant breeding. Neither Saran nor Bashaw discloses or suggests this claim limitation. Thus, the Examiner has not shown all the limitations of the claimed invention in the prior art, and, therefore, a *prima facie* case of obviousness has not been established concerning claim 7.

Claim 8 is drawn to method of claim 1 wherein the nongametophytic ovule and ovary tissues comprise at least one of the nucellus, integument, pericarp, hypanthium, or pistil wall. Neither Saran nor Bashaw discloses or suggests this limitation. Thus, the Examiner has not shown all the limitations of the claimed invention in the prior art, and, therefore, a *prima facie* case of obviousness has not been established concerning claim 8.

Claim 9 is drawn to the method of claim 1 wherein the genetic material comprises genomes from each set of delineated lines that confer appropriate degrees of asynchrony as measured by the expression of apomixis. Neither Saran nor Bashaw discloses or suggests this limitation. Thus, the Examiner has not shown all the limitations of the claimed invention in the prior art, and, therefore, a *prima facie* case of obviousness has not been established concerning claim 9.

Claim 11 is drawn to the method of claim 1 wherein the genetic material comprises genes from each set of delineated

lines that confer appropriate degrees of asynchrony as measured by the expression of apomixis. Neither Saran nor Bashaw discloses or suggests this limitation. Thus, the Examiner has not shown all the limitations of the claimed invention in the prior art, and, therefore, a *prima facie* case of obviousness has not been established concerning claim 11.

Claims 12 is drawn to the wherein said selected hybrid lines display a reproductive anomaly selected from the group consisting of apospory, diplospory, and polyembryony. Neither Saran nor Bashaw discloses or suggests this limitation. Thus, the Examiner has not shown all the limitations of the claimed invention in the prior art, and, therefore, a *prima facie* case of obviousness has not been established concerning claim 12.

Claim 16 is drawn to the method of claim 1 wherein the selected hybrid lines are genetically diploid. Neither Saran nor Bashaw discloses or suggests this limitation. Thus, the Examiner has not shown all the limitations of the claimed invention in the prior art, and, therefore, a *prima facie* case of obviousness has not been established concerning claim 16.

Claim 17 is an independent claim drawn to a method for obtaining apomictic plants from sexual plants comprising: (a) identifying divergence in flowering responses to various photoperiods within a plant species or group of related plant species; (b) obtaining two sets of lines that are differentiated

by their flowering responses to various photoperiods; (c) identifying within and between these sets of lines divergence in start times and durations of female or seed developmental stages relative to development of nongametophytic ovule and ovary tissues; (d) obtaining two sets of delineated sexual lines that are differentiated by their flowering responses to various photoperiods and by their start times and durations of female or seed developmental stages relative to development of nongametophytic ovule and ovary tissues; and (e) producing hybrid lines from the sets of delineated sexual lines such that the progeny exhibit apomixis. Neither Saran nor Bashaw discloses or suggests identifying and obtaining plants that are divergent with respect to flowering responses to different photoperiods and then identifying divergence with respect to start times and durations of female or seed developmental stages in these lines. Neither Saran nor Bashaw discloses or suggests obtaining two sets of delineated sexual lines that are differentiated by their flowering responses to various photoperiods and by their start times and durations of female or seed developmental stages and then producing hybrids between such lines that exhibit apomixis. Thus, the Examiner has not shown all the limitations of the claimed invention, and, therefore, a *prima facie* case of obviousness has not been established concerning claim 17.

Claim 18 is an independent claim drawn to a method for

obtaining aposporic, diplosporic, or polyembryonic plants from sexual monocotyledonous or dicotyledonous plants comprising: (a) identifying divergence in flowering responses to various photoperiods; (b) obtaining two sets of lines that are differentiated by their flowering responses to various photoperiods; (c) identifying within and between such sets of lines divergence in start times and durations of female or seed developmental stages selected from the group consisting of archespore formation, megasporogenesis, megagametogenesis, and early embryony relative to the development of nongametophytic ovule and ovary tissues selected from the group consisting of nucellus, integument, pericarp, hypanthium, and pistil wall; (d) obtaining two sets of delineated sexual lines that are differentiated by their flowering responses to various photoperiods and start times and durations of female or seed developmental stages; and (e) producing progeny by sexual reproduction or somatic cell hybridization of the two sets of delineated sexual lines such that apomixis is expressed in such progeny. Neither Saran nor Bashaw discloses or suggests identifying divergence and selecting lines that are divergent with respect to responses to various photoperiods and then identifying divergence in start times and durations of female developmental stages within such lines. Similarly, neither Saran nor Bashaw discloses or suggests obtaining delineated sexual

lines that are differentiated by their flowering responses to various photoperiods and start times and durations of female or seed developmental stages and producing hybrids of such sets of delineated sexual lines such that apomixis is expressed. Thus, the Examiner has not show all the limitations of the claimed invention in the prior art, and, therefore, a *prima facie* case of obviousness has not been established.

Claim 23 is dependent on claim 18 and, thus incorporates by reference all the limitations of claim 18. Since all the limitations of claim 18 are not shown in the prior art, it necessarily follows that all the limitations of claim 23 are not shown in the prior art. Further, claim 23 is drawn to the method of claim 18 wherein producing of progeny of the delineated sexual lines described in claim 18 is by sexual reproduction. Neither Saran nor Bashaw discloses or suggests this limitation. Thus, the Examiner has not shown all the limitations of the claimed invention in the prior art, and, therefore, a *prima facie* case of obviousness has not been established concerning claim 23.

Claim 34 is an independent claim drawn to a method for producing apomictic plants from two or more sexual plants of the same or related species comprising: (a) obtaining two sexual lines whose female reproductive phenotypes differ such that under similar environmental conditions asynchrony in female developmental schedules between the two lines occurs; and (b)

hybridizing the two sexual lines by plant breeding or somatic cell hybridization to induce apomixis, obtaining progeny from such hybridizing of the two sexual lines, and selecting apomictic plants from among the progeny. Neither Saran nor Bashaw discloses or suggests hybridizing such sexual lines and selecting apomictic progeny thereof as a method for producing apomictic plants. Thus, the Examiner has not shown all the limitations of the claimed invention in the prior art, and, therefore, a *prima facie* case of obviousness has not been established concerning claim 34.

For the reasons set out above, it is respectfully submitted that a *prima facie* case of obviousness has not been established for any of the claims currently under consideration. Therefore, withdrawal of the rejection of claims 1-9, 11, 12, 16-18, 23, and 34 under 35 U.S.C. § 103(a) is respectfully requested.

VIII. Conclusion

Should the Examiner deem it advisable to conduct a telephone interview for any reason, the undersigned attorney would be most agreeable to receiving a collect telephone call to expedite the prosecution of the application.

For the reasons given above, Applicant respectfully requests reconsideration and allowance of Claims 1-9, 11-12, 16-18, 23, and 34-37 and passage of this application to issue.

DATED this 9th day of September, 2002.

Respectfully submitted,

Alan J. Howarth

Alan J. Howarth, Ph.D.
Registration No. 36,553
Customer No. 020450

Clayton, Howarth & Cannon, P.C.
P.O. Box 1909
Sandy, UT 84091
Telephone: (801) 255-5335
Facsimile: (801) 255-5338

S:\CHC Files\T 4--\T4088\Cont\T4088con.response.09092002.wpd

Version with Markings to Show Changes Made

1. (Thrice Amended) A method for obtaining apomictic plants from sexual plants comprising:

(a) obtaining at least two sets of delineated sexual lines from a plant species or group of related plant species that are differentiated by their flowering responses to various photoperiods and by their start times and durations of female or seed developmental stages relative to development of nongametophytic ovule and ovary tissue; and

(b) hybridizing said sets of delineated sexual lines, recovering seed from the hybridization, sowing said seed, and selecting hybrid lines that [contain genetic material of each said set of delineated lines such that asynchronous floral development, and therefore apomixis, is conferred] express apomixis.

2. (Once Amended) The method of claim 1 wherein the differentiation in flowering [response] responses occurs within a member of the group consisting of short-day plants, long-day plants, dual-day-length plants, intermediate-day-length plants, [and] ambiphotoperiodic plants, and day-neutral plants.

3. (Twice Amended) The method of claim 1 wherein the differentiation in flowering [response] responses occurs across

at least one member of the group consisting of short-day plants, long-day plants, dual-day-length plants, intermediate-day-length plants, ambiphotoperiodic plants, and day-neutral plants.

5. (Once Amended) The method of claim 1 wherein differentiation in start times and durations of female or seed developmental stages occurs within a member selected from the group consisting of archespore formation, megasporogenesis, and megagametogenesis, and early embryony.

6. (Once Amended) The method of claim 1 wherein differentiation in start times and durations of female or seed developmental stages occurs across at least one member selected from the group consisting of archespore formation, megasporogenesis, and megagametogenesis, and early embryony.

7. (Once Amended) The method of claim 1 wherein differentiation in start times and durations of female or seed developmental stages is [obtained by] selected for as a trait in a plant breeding step.

9. (Once Amended) The method of claim 1 wherein the [genetic material comprises] hybrid lines comprise genomes from

each set of delineated lines [that confer appropriate degrees of asynchrony as measured by the expression of apomixis].

17. (Thrice Amended) A method for obtaining apomictic plants from sexual plants comprising:

(a) identifying divergence in flowering responses to various photoperiods within a plant species or group of related plant species;

(b) obtaining two sets of lines of said plant species or group of related plant species that are differentiated by their flowering responses to various photoperiods;

(c) identifying within and between said sets of lines divergence in start times and durations of female <u>or seed</u> developmental stages relative to development of nongametophytic ovule and ovary tissues;

(d) obtaining two sets of delineated <u>sexual</u> lines of said species or group of related species that are differentiated by their flowering responses to various photoperiods and by their start times and durations of female <u>or seed</u> developmental stages relative to development of nongametophytic ovule and ovary tissues; and

(e) producing hybrid lines that [contain genetic material of each said set of delineated lines such that asynchronous floral development, and therefore apomixis, is conferred] <u>express</u>

apomixis by hybridizing said two sets of delineated sexual lines, recovering seed from the hybridization, sowing said seed, and selecting said apomictic hybrid lines.

18. (Thrice Amended) A method for obtaining aposporic, diplosporic, or polyembryonic plants from sexual monocotyledonous or dicotyledonous plants comprising:

(a) identifying divergence in flowering responses to various photoperiods within a plant species or group of related plant species;

(b) obtaining two sets of lines of said plant species or group of related plant species that are differentiated by their flowering responses to various photoperiods;

(c) identifying within and between said sets of lines divergence in start times and durations of female or seed developmental stages selected from the group consisting of archespore formation, megasporogenesis, and megagametogenesis, and early embryony relative to the development of nongametophytic ovule and ovary tissues selected from the group consisting of nucellus, integument, pericarp, hypanthium, and pistil wall;

(d) obtaining two sets of delineated sexual lines of said species or group of related species that are differentiated by their

(i) flowering responses to various photoperiods such

that divergence occurs within a member or across more than one member selected from the group consisting of short-day plants, long-day plants, dual-day-length plants, intermediate-day-length plants, ambiphotoperiodic plants, and day-neutral plants, and

(ii) start times and durations of female or seed developmental stages selected from the group consisting of archespore formation, megasporogenesis, megagametogenesis, and early embryony relative to the development of nongametophytic ovule and ovary tissues selected from the group consisting of nucellus, integument, pericarp, hypanthium, and pistil wall such that divergence occurs within one member or spans more than one member of such female developmental stages; and

(e) producing progeny by sexual reproduction or somatic cell hybridization of said two sets of delineated sexual lines [polyploid, triploid, diploid , or aneuploid lines] such that apomixis is expressed in said progeny.

23. (Amended) The method of claim 18 wherein said producing progeny [polyploid, triploid, diploid , or aneuploid lines] is by sexual reproduction.

Please add the following new claims to the application:

35. (New) A method for obtaining apomictic plants from sexual plants comprising:

(a) obtaining at least two sets of delineated sexual lines from a plant species or group of related plant species selected from families that exhibit apomixis in nature and that are differentiated by their flowering responses to various photoperiods and by their start times and durations of female or seed developmental stages relative to development of nongametophytic ovule and ovary tissue; and

(b) hybridizing said sets of delineated sexual lines, recovering seed from the hybridization, sowing said seed, and selecting hybrid lines that express apomixis.

36. (New) A method for obtaining apomictic plants from sexual plants comprising:

(a) obtaining at least two sets of delineated sexual lines from a plant species or group of related plant species selected from the grass family and that are differentiated by their flowering responses to various photoperiods and by their start times and durations of female or seed developmental stages relative to development of nongametophytic ovule and ovary tissue; and

(b) hybridizing said sets of delineated sexual lines, recovering seed from the hybridization, sowing said seed, and selecting hybrid lines that express apomixis.

37. (New) A method for obtaining apomictic plants from sexual plants comprising:

(a) obtaining at least two sets of delineated sexual lines from a plant species or group of related plant species selected from the *Asteraceae* family and that are differentiated by their flowering responses to various photoperiods and by their start times and durations of female or seed developmental stages relative to development of nongametophytic ovule and ovary tissue; and

(b) hybridizing said sets of delineated sexual lines, recovering seed from the hybridization, sowing said seed, and selecting hybrid lines that express apomixis.